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(54) Device for operating flexible elements.

(57) There is described a device for operating flexible elements (15, 16) essentially made up of a rotating drum (3) around which are wound flexible elements (15, 16) to be advanced, a container (2) of the drum equipped with a series of rubber rollers (6) which hold said flexible elements (15, 16) in adherence with the outer surface of the drum and which has a

longitudinal slot which permits passage of the flexible elements (15, 16) from the inside to the outside of the container (2), a moving guide (14) for said flexible elements (15, 16) positioned across the drum (3) and which moves with reciprocating movement and facilitates winding or unwinding of the flexible element (15, 16) on or from the drum (3).

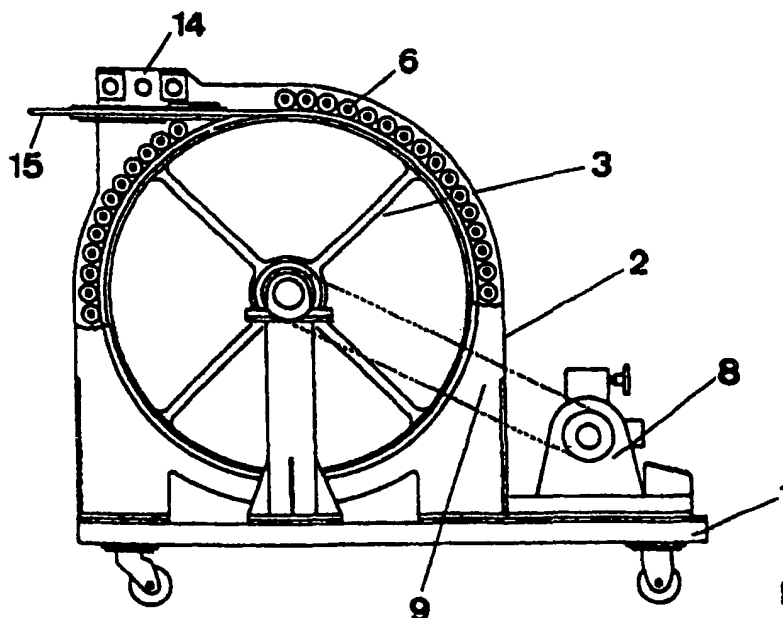


FIG 1

## TECHNICAL SECTION

The present invention relates to a device for operating flexible elements.

The device is particularly useful for automatically advancing in a controlled manner flexible elements which must be inserted in very long longitudinal cavities such as for nozzles for cleaning the inner surfaces of a pipe by water or other pressurized liquids, painting the internal surface of piping, insertion of cables in sheaths designed to cover them, insertion of radiography devices inside piping, etc..

### THE TECHNICAL PROBLEM

It is known that one of the main problems encountered in advancing a flexible element inside a very long cavity consists of the poor ability of the flexible element to absorb resistance to advancement without distortion in the part not yet inserted in the cavity. Said undesirable distortion of the flexible element, in addition to being a factor of rapid wear of said element, makes the advancing motion of the flexible element irregular with resulting reduction of the quality of the work performed and increase of costs due to a greater number of passes to obtain the same results than there would be if motion were controlled in a uniform manner.

Finally where the flexible element is a hose containing a liquid under very high pressure, e.g. up to 3,000 bar, as in the case of cleaning the internal surfaces of the tubes of a tube nest, irregular advancement of the hose can be very dangerous for the operator who has to handle said hose.

### PREVIOUS ART

The operations which require the use of a hose to be inserted in a very long longitudinal cavity are normally performed in a nonautomatic manner and manually. The operator inserts the end of the hose into the longitudinal cavity in which said hose must run and pushes the hose until it reaches the other end of the cavity. If the flexible element must remain in the same place, (e.g. if it is a cable), the operation is terminated. If the hose was used for inspection or cleaning the motion is reversed and the hose is drawn back until it goes out of the end of the cavity in which it had been inserted.

In the case of cleaning or internal treatment of tube bundles with pressurized liquids, the insertion and withdrawal of the hose are performed tube by tube with a single hose and interrupting the flow of liquid which passes through the hose before withdrawing it from each tube and turning on flow again after insertion in the next tube.

It is just these insertion and withdrawal operations which represent the greatest danger for safety of the operator in case he does not turn off in a timely manner the liquid in the hose before its withdrawal from each tube. The liquid jet under very high pressure which comes out of the operating end of the hose, no longer contained by the walls of the tube being treated, can very seriously injure the operator or persons in the vicinity of the tube nest being treated.

It is thus clear why tube nests are not cleaned directly on the plant where they are installed but are disassembled and placed on supports which make their treatment easier and safer.

A second defect of these manual operations consists of the fact that the operator tends to stop the flow of liquid inside the hose well before withdrawing it from the tube being worked on to increase his own safety and this circumstance reduces the effectiveness of the cleaning because a considerable part of the tube undergoes a single cleaning pass and not both passes of the advancing and withdrawal phases.

### DETAILED DESCRIPTION OF THE INVENTION

The Applicant has long experience in the field of hydrokinetic systems for cleaning and maintenance of chemical and petroleum plants and has conceived and perfected a device which resolves in a highly satisfactory manner the problems of operation safety and work quality described above.

In accordance with a basic characteristic the device of the invention consists of the following basic parts:

- a) a rotating drum around which are wound the flexible elements to be handled,
- b) a container of said drum equipped with a series of rollers which hold said flexible elements in adherence with the outer surface of the drum and said container having a transvers aperture which permits passage of the flexible elements from the inside of the container to the outside thereof,
- c) a moving guide for said flexible elements positioned transversely to the drum and which moves with reciprocating motion and aids winding or unwinding of the flexible element onto or from the drum,
- d) one or more flexible elements of a length such as to meet the necessity for which the device is designed to be employed, and
- e) a motor which drives through appropriate motion reducers and transmitters rotation of the drum and movement of the moving guide in a mutually coordinated manner.

In accordance with a basic characteristic of the invention the relationship of the drum diameter to

the diameter of the flexible element is such as to permit winding and unwinding of the flexible element within the allowed distortion limits of the hose.

The width of the drum is readily calculated on the basis of the diameter and length of the flexible element which is to be wound thereon in such a manner that the coils of the flexible elements would never overlap each other.

Typically a drum with a diameter of 80cm and width of 45cm allows winding of 50m of a hose having a diameter between 1.4cm and 1.6cm.

It is clear that several flexible elements can be wound around the drum parallel to each other in such a manner as to cause them all to move simultaneously and obtain a multiplication of the services of the device.

Another important characteristic of the device of the invention consists of the ratio of the diameter of the rollers to that of the drum, which is typically between 1:30 and 1:10.

The rollers have two central axial pivots which permit free rotation thereof while holding them at the same time in position around the drum and interacting with the two circular guides made in the side walls of the container.

In a typical form of embodiment of the device in accordance with the invention said rollers rotate by friction with the outer edges of said drum. The outer edges of the drum and the rollers are covered with rubber or other elastomeric substance to facilitate motion transmission. In the preferred form of embodiment of the invention the coating of the outer edges of the drum is assured by the insertion of two belts of selected material having the same diameter as the drum and a thickness such as to ensure friction with the rollers. This form of embodiment is particularly preferred because it facilitates maintenance of the device and permits easy replacement of the belts when they are worn.

In accordance with one preferred form of embodiment of the invention the device comprises a control system which regulates the speed of feed of the flexible elements and the distance to be travelled by the heads of said elements before reversal of the unwinding motion and starting of the rewinding of the hoses on the drum.

On the leading ends of the flexible elements of the device are appropriately fixed tools to be used for the work which the device is to perform, i.e. radioactive elements (in the case of radiography of tubes), nozzles of various kinds for cleaning or painting, etc.

Considering the extreme adaptability and great performance of the device of the invention every technician having problems of using flexible elements will have no difficulty in adapting the device of the invention to his own particular problem.

If the flexible elements of the device in accordance with the invention are hoses for cleaning or painting they are connected to the liquid feed pump by appropriate unions located in the central part of the drum.

The device of the invention is connected to the object to be treated by a tube of appropriate length and a diameter slightly greater than that of the flexible element of the device. The flexible element of the device is inserted in said tube at the outlet of the device and is run therein up to the opening of the tube to be treated. The connecting tube is fixed to the device of the invention by a flange or other union while connection to the object to be treated is made by a rigid terminal part. Said rigid part has typically a length between 10cm and 100cm and is inserted a few centimetres in the longitudinal cavity to be treated and acts at the same time as a handgrip for the operator in such a manner as to facilitate movement of the flexible element from one cavity to the next one to be treated at the end of each operation. In the preferred form of embodiment of the invention said handgrip comprises also the control pushbuttons for the operator.

In the forms of embodiment of the invention which have several flexible elements parallel to each other and which move simultaneously the connecting tube can be either one only for all the flexible elements operated or one for each of said elements.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the annexed drawings:

FIG. 1 shows a schematic vertical cross section of the device in accordance with the invention, FIG. 2 shows a schematic horizontal cross section of said device, and

FIG. 3 shows a vertical cross section of a detail of the device rotated 90° from the one shown in FIG. 1.

With particular reference to the annexed drawings there is described below a preferred form of embodiment of the device in accordance with the invention adapted for cleaning the inside of the tubes of a heat exchanger with a tube nest.

On a wheeled cart 1 there is mounted a container 2 which encloses a drum 3 whose external surface 4 is appropriately shaped with a double groove 5 which allows simultaneous winding or unwinding of two hoses 15 and 16 which are held pressed against the drum 3 by a series of rollers 6 arranged around the drum 3.

A ratomotor 8 mounted on the cart 1 moves the drum 3 through a roller chain 9. A second roller chain 10 unites the shaft 11 of the drum 3 to a worm screw 12 which moves with reciprocating motion a saddle 14 over which pass the two hoses

15 and 16 and to which is fixed a tube (one for both hoses) of appropriate length which permits connection of the device to the tube nest to be cleaned. The shaft 11 of the drum is hollow and communicates with the end of the hoses 15 and 16 wound on the drum. Said hollow shaft 11 has a pressurized seal 17 which permits connection thereof to the feed piping for pressurized cleaning. The rollers 6 have a rubberized surface and are rotated by friction with the two rubber belts 18 inserted on the side edges of the drum 3.

The device illustrated is also equipped with a control panel which permits regulation of the feed speed of the hoses and reversal of movement on the basis of the programme set on the control panel for the length of the tube to be cleaned.

The above device has been used on exchangers with tubes as long as 24 metres by a single operator who could operate the two cleaning hoses simultaneously with much less fatigue than when using a single hose without the device of the invention.

Among the other advantages found in the use of the above device particularly interesting is substitution of the outlet nozzles of the pressurized water placed at the ends of the tubes with other types much more effective for cleaning but which it is not possible to use with only manual operations due to the excessive effort required of the operator for operation.

#### Claims

1. Device for the operation of flexible elements comprising the following basic parts:
  - a) a rotating drum (3) around which are wound the flexible elements (15, 16) to be handled,
  - b) a container (2) of said drum (3) equipped with a series of rollers (6) which hold said flexible elements (15, 16) in adherence with the outer surface of the drum (3) and said container (2) having a transverse aperture which permits passage of the flexible elements (15, 16) from the inside of the container (2) to the outside thereof,
  - c) a moving guide (14) for said flexible elements (15, 16) positioned transversely to the drum (3) and which moves with reciprocating motion and aids winding or unwinding of the flexible element (15, 16), onto or from the drum (3),
  - d) one or more flexible elements (15, 16) of a length such as to meet the necessity for which the device is designed to be employed, and
  - e) a ratiomotor (8) which drives through appropriate motion reducers and transmits rotation of the drum (3) and movement of the moving guide (14) in a mutually coordinated manner.
2. Device in accordance with claim 1, characterized in that motion is transmitted from the ratiomotor (8) to the drum (3) through a roller chain (9).
3. Device in accordance with claim 1, characterized in that the moving guide (14) is moved by a worm screw (12) connected through a roller chain (10) to the drum shaft (11).
4. Device in accordance with claim 1, characterized in that the ratio of the drum (3) diameter to that of the flexible element (15, 16) is such as to permit winding and unwinding of the flexible element (15, 16) within the allowed distortion limits of the hose.
5. Device in accordance with claim 1, characterized in that the width of the drum (3) is such as to permit winding of the flexible elements (15, 16) in such a manner that the coils of the flexible elements (15, 16) wound do not overlap.
6. Device in accordance with claim 1, characterized in that the ratio of the diameter of the rollers (6) to that of the drum (3) is typically between 1:30 and 1:10.
7. Device in accordance with claim 1, characterized in that the rollers (6) have two central axial pivots which allow them free rotation while holding them at the same time in position around the drum (3) and interacting with two circular guides made in the side walls of the container.
8. Device in accordance with claim 1, characterized in that said rollers (6) rotate by friction with the outer edges of said drum (3) both the outer edges of the drum (3) and the rollers (6) being covered with rubber or other elastomeric substance.
9. Device in accordance with claim 1, characterized in that said rollers (6) rotate by friction with the outer edges of said drum on which are inserted two belts (18), one on each side, of rubber or other elastomeric substance of a thickness such as to assure contact with said rollers (6).
10. Device in accordance with claim 1, characterized in that the flexible elements (15, 16) con-

sist of hoses which carry water under pressure and are used for cleaning tube nests.

11. Device in accordance with claim 1, characterized in that said drum (3) has a diameter of 80cm and a width of 45cm and permits winding of 50m of hose having a diameter between 1.4cm and 1.6cm.

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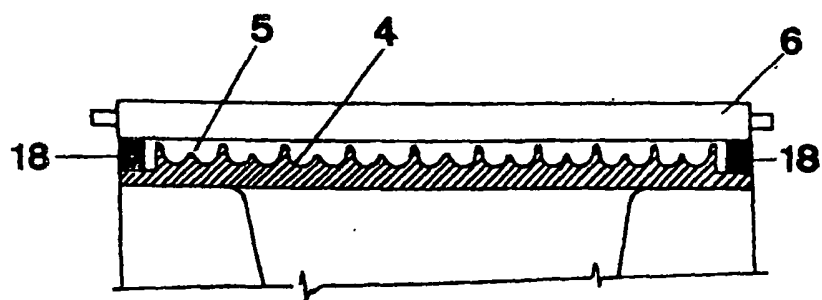
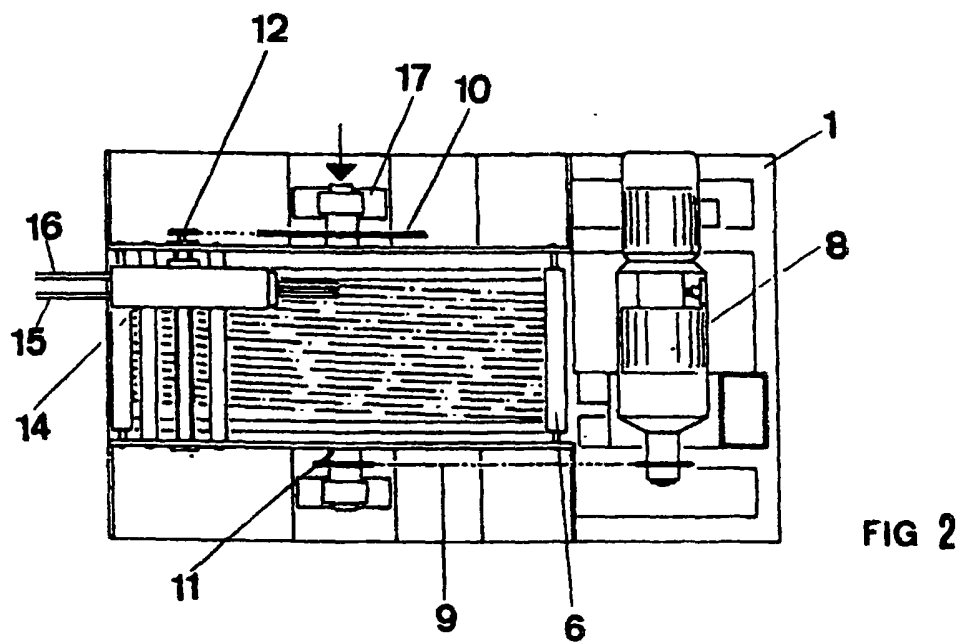
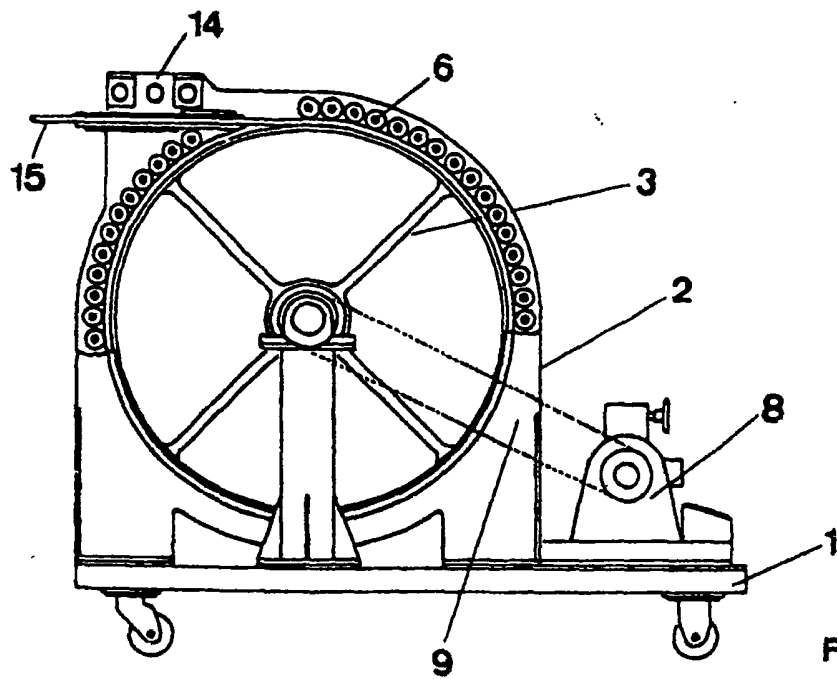
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## EUROPEAN SEARCH REPORT

Application Number

EP 91 10 2239

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-2 642 462 (NITRO NOBEL AB) * page 9, line 19 - page 10, line 25 ** page 12, lines 12 - 31; figures 2, 5 * - - - -	1,2,4-7	B 65 H 75/34 B 65 H 75/44
X	FR-A-2 195 229 (CATERPILLAR MITSUBISHI LTD.) * page 5, line 14 - page 6, line 15; figures 1, 2 * - - - - -	1-7	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 65 H
The present search report has been drawn up for all claims			
Place of search		Date of completion of search	Examiner
The Hague		17 June 91	GOODALL C.J.
<div>CATEGORY OF CITED DOCUMENTS</div> <div>X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention</div> <div>E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &amp;: member of the same patent family, corresponding document</div>			





- EPODOC / EPO

PN - DE4442513 A 19950810  
PD - 1995-08-10  
PR - DE19944442513 19941130; DE19940001806U 19940203  
OPD - 1994-02-03  
TI - Transport storage device for flexible hoses  
AB - The device stores a hose (6) such that one end can be extended when the hose is to supply fluid or gas whilst the other end remains connected to a short pipe (5) which is connected to the protective container (1) and opens to the outside where it can have a hose coupling (5b). The hose is stored in the protective container bent round one or more times and has short longitudinal sections (14) which are each connected on one or both sides to 180 deg. bends (15). The protective container can be tubular.

IN - SCHAUMEIER MAX (DE)  
PA - TAURUS MASCHINENBAU E SCHAUMEI (DE)  
ICO - L65D85/08  
EC - B65D25/10E ; F24F7/06D ; F24F13/02  
IC - B65D85/04 ; B65D25/10 ; B65D43/08  
- WPI / DERWENT

TI - Transport storage device for flexible hoses - is protective container in which compacted hose is arranged with one end for extension and other end fixed to short connecting pipe attached to container and opening outwards for coupling to other fittings

PR - DE19940001806U 19940203  
PN - DE4442513 A1 19950810 DW199537 B65D85/04 012pp  
PA - (TAUR-N) TAURUS MASCHBAU SCHAUMEIER GMBH & CO KG  
IC - B65D25/10 ; B65D43/08 ; B65D85/04  
IN - SCHAUMEIER M  
AB - DE4442513 The device stores a hose (6) such that one end can be extended when the hose is to supply fluid or gas whilst the other end remains connected to a short pipe (5) which is connected to the protective container (1) and opens to the outside where it can have a hose coupling (5b).

- The hose is stored in the protective container bent round one or more times and has short longitudinal sections (14) which are each connected on one or both sides to 180 deg. bends (15). The protective container can be tubular.

- USE/ADVANTAGE - For fire-fighting hoses etc. Allows compact storage protected against external damage, and easy coupling of the hose to other equipment. (Dwg.5/9)

OPD - 1994-02-03  
AN - 1995-276325 [37]

